Weatherwise

Mount McKinley Weather Experiences

Cirrus

The Great Southern Glaze Storm of 1951

Telecasting the Weather

December, 1951, Brings Winter and Summer

Vol. 5, No. 1, February, 1952

"SOME PEOPLE ARE WEATHERWISE BUT MOST ARE OTHERWISE"—BENJAMIN FRANKLIN

WEATHERWISE

THE MAGAZINE ABOUT WEATHER

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Science and Meteorology on Alaska's Highest Mountain

MOUNTAINEERS know the value of weather, and no mountaineer applies better weather practice in his expeditions to high places than does Bradford Washburn, director of the Boston Museum of Science and author of this month's feature WEATHERWISE article. His success in conquering many of Alaska's peaks, including three ascents of Mt. McKinley, highest point in North America, is in no small measure due to his careful advance study of long-term weather patterns and day-to-day vagaries of a particular locality. On 19 visits to Alaska, he has carried meteorological instruments, in order to keep accurate records of weather conditions no matter how remote his location may have been.

Mt. McKinley was first seen in 1794 by the English navigator, George Vancouver, while he was exploring the southern coast of Alaska — the mountain is easily visible hundreds of miles away. Its present name, in honor of William McKinley, was proposed by W. A. Dickey in 1896. The north peak, 850 feet lower than the south peak, was climbed in 1910 in one day from a camp at 11,000 feet, by three prospectors, Anderson, Taylor, and McGonagall. It was not until 1913 that the south peak was finally scaled, by a full-fledged expedition under Archdeacon Hudson Stuck. His was made a difficult task by severe damage to the mountain ridges by earthquakes the year before. In 1932, a ski-equipped expedition scaled both peaks.

Bradford Washburn, who has been on McKinley every month of the year except January and February, conducted the first mapping flights over the mountain in 1936, and again took aerial photographs for the National Geographic Society in 1937 and 1938. He was the representative of the Army Air Forces on the U. S. Army expedition that climbed McKinley in 1942, the third ascent of the mountain and his first. He was the leader of an Air Force test party that spent 40 days in the wilderness just east of the mountain in November-December, 1944. This group snowshoed 180 miles in temperatures down to —40° Fahrenheit. The next spring he led another group testing arctic emergency equipment for 48 days.

Three months were spent on Mt. McKinley by the 1947 expedition led by Mr. Washburn, a 13-man party including his wife, who became the first woman ever to climb Alaska's highest peak. Assisted by airplane this scientifically minded expedition surveyed to set up ground

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Cover: An aerial view of Mt. McKinley, in Alaska, from the northeast. The south peak (summit) is at the left, enveloped by a typical southwesterly cloud-cap storm. Although there is a tremendous gale blowing above 18,000 feet, it is calm in the foreground. The north peak is at the right. Karstens Ridge and Harper Glacier, the route of ascent normally followed, lie directly up the center of the scene. Photograph by Bradford Washburn. (See page 3.)

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An aerial view of the two peaks of Mt. McKinley, seen from an altitude of 21,000 feet, looking south-southwest. The north peak is in the right foreground. The prevailing winds have swept practically all snow from the southeastern faces, and have produced tremendous accumulations on the northern slopes. All photographs in this article are by the author.

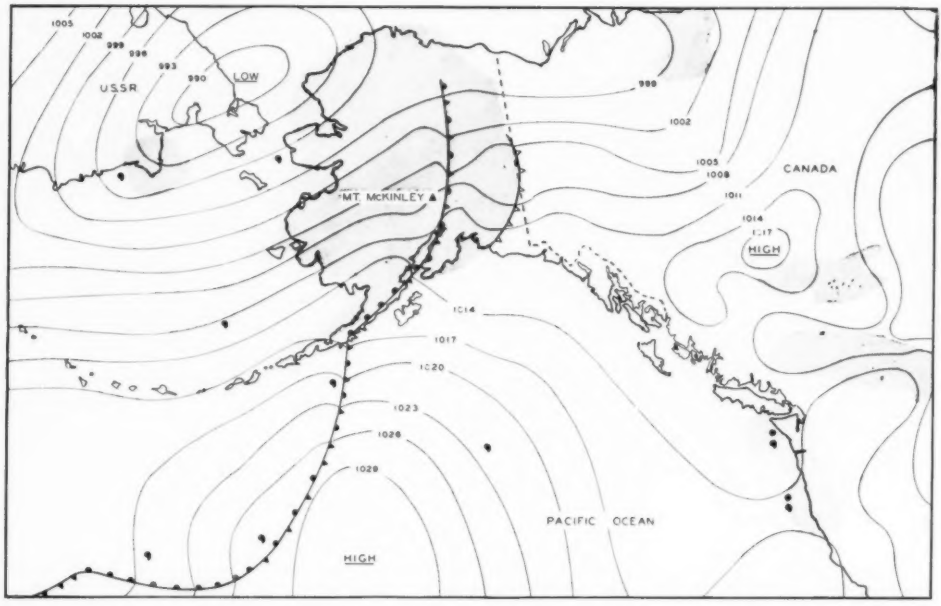
Mount McKinley Weather Experiences

BRADFORD WASHBURN, DIRECTOR, BOSTON MUSEUM OF SCIENCE

THE WEATHER on Mt. McKinley follows two markedly different patterns, one the succession of storms that pass over the peak, the other the weather generated by the great mountain itself. This is typical of all the high ranges of the world, but it is particularly pronounced on McKinley because the mountain rises, almost completely isolated, to an altitude of 20,290 feet out of the lowlands. It is thus probably the greatest vertical uplift on earth rising out of a level plain. It is also located only 130 miles from tidewater at the head of Cook Inlet, and therefore receives without the slightest obstruction the full force of all the coastal storms which pass its way.

The predominant storms are, of course, southwesters which originate in the western Aleutians and travel across the Gulf of Alaska. At certain times the Hawaiian high pressure zone, the position of which tends to control the path of the Aleutian storms, moves northward and invades the lower part of the Gulf of Alaska. This shunts the Aleutian storm centers northeastward instead of eastward as normally, and they travel up the Kuskokwim Valley, across the Alaskan interior, passing almost directly over Mt. McKinley and the Alaska Range.

A disturbance of this sort can bring tremendous turbulence and violent winds on the peak. Last summer the frontal passage of



A simplified weather map of the North Pacific region, showing the position of the great storm of July 5, 1951, at 8:30 p.m. Central Alaska time. The storm's principal front had just passed over Mt. McKinley. Map data courtesy USWB, Anchorage, Alaska.

Bradford Washburn on the summit of Mt. McKinley, July 10, 1951, at 5:00 p.m., after completing his third ascent of the mountain.

one such storm in early July brought a wild blizzard, with a three-cup anemometer registering 87 miles per hour at our 13,000-foot camp on the west side of the mountain.

The big storms, except for an occasional northerly or northeasterly windstorm in the winter months, usually bring "warm" weather to the mountain. At 18,000 feet, where we lived for three weeks in 1947, the average clear weather nighttime temperatures were approximately 25° below zero Fahrenheit. During the southwesters this temperature rose to zero or on occasion even a bit higher.

These southwesters are preceded by the usual warnings of a warm front: high cirrus clouds and increasing winds. From the time the first 30,000-foot cirrus streamer appears until the peak is actually enveloped in overcast and precipitation begins, usually about 12 hours pass. Disturbances of this sort arrive slowly and methodically and are therefore of no great danger to the climber, despite their ultimate violence.

McKinley enjoys very little really clear weather. Thus, during our 1947 expedition, we spent 89 days on the mountain and had

Mt. McKinley seen from a distance of about 70 miles, looking southwest across Mt. McKinley National Park. The great mass of the mountain towers above its surroundings. Peters Dome (10,570 feet) appears just to the right of McKinley; Mt. Foraker is hidden directly behind the big mountain.

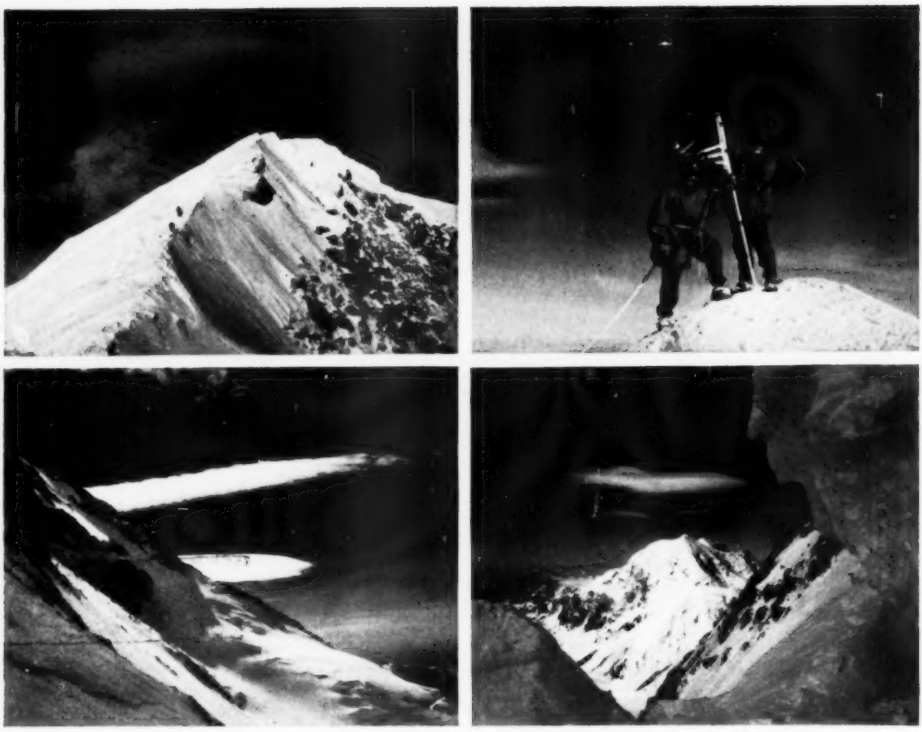
only five CAVU days. A dozen or more days started clear and then clouded into stormy weather, or vice versa, but only five days were really clear for even as little as 12 consecutive hours.

McKinley's best weather is in July, when the Alaskan interior is blanketed almost daily in seas of clouds originating from convection over the moist lowlands. In April, the mountain as well as the lowlands tend to be magnificently clear, but unfortunately at this time of year the peak is almost constantly swept by bitter northeasterly and northwesterly gales.

It is generally agreed that the practical climbing season on McKinley begins in May, lasting through the last of July. However, it is during July itself that the conditions on the upper part of the mountain are mildest and most stable. Clear from around midnight until about 7 o'clock in the morning, the July skies first begin to fill with fracto-cumulus clouds from 7 till 9 in the morning. They usually extend from 4,000 to about 6,000 feet. During the morning these scattered clouds rapidly fuse into a more or less solid ceiling and thicken, so that by evening they reach from a lower altitude of about 7,000 feet up to about 12,000 feet on top. Frequently, great cumulus anvils push far above this ceiling and reach as high as 20,000 or 25,300 feet by late evening. The cooling of the short twilight-like night dissipates this overcast, and then the process resumes in the morning.

Most dangerous to the climber of all McKinley's storms are those created by the peak

A sea of developing cumulus clouds topping about 10,000 feet, July 11, 1951, as seen from the west buttress at a height of 17,000 feet, looking westward.



Scenes of Mt. McKinley, the upper two taken on July 10, 1951. In the upper left, climbers begin the last 100 yards to the summit of the south peak. This view is looking eastward: note the snow accumulation on the north (left) side of the mountain, while the south slope is swept almost bare. The clouds are the remains of the cap that caused snow on the summit earlier in the day; the sky was completely clear 15 minutes after this picture was taken. In the upper right, Capt. William D. Hackett, U. S. Army, and James E. Gale are on the top after the first ascent by the west face. The snow is windpacked to the hardness of concrete. The flagpole (not the flag) has been in this same position for four years, having been planted there by the 1947 Washburn expedition.

The lower pictures, taken July 9, 1951, from a camp at 15,500 feet, show the morning development of lenticular clouds (left) over Mt. McKinley summit, and (right) over Mt. Foraker, which has a height of 17,400 feet.

itself. The ambient air around McKinley is naturally much warmer than the mountain itself during the summer months. It is also likely to be relatively moist. If the wind aloft is reasonably brisk (20-50 miles per hour), this air, when it hits the peak and streams up over and around it, creates a lenticular cloud-cap which rapidly varies in size and tendency to precipitate, depending upon the temperature and humidity of the air mass. Storms of this sort, while the entire region about the peak is cloudless, can appear or disappear with incredible swiftness (15-20 minutes) and often bring fierce blizzards of short duration.

These storms almost invariably clear away in the evening when the air around the mountain chills. Their unpredictable character makes them something constantly to be watched and respected by even the most experienced climber. A sound knowledge of this type of weather contributed directly to the success of our July 10th ascent of Mt. McKinley last summer. We reached an altitude of 18,200 feet at Denali Pass around noon, and saw that the peak above 18,500 feet was completely enveloped in a lenticular cirrus streamer. The lowlands below were clear except for a few scattered clouds — the normal fractocumulus and cumulus of fair

weather. There was a 25-30 mile per hour westerly breeze and the temperature stood at zero in the sun.

We knew McKinley intimately and elected to go ahead into the overcast, climbing blind for four hours to an altitude of 20,000 feet. We were certain that late in the afternoon this local storm would dissipate, as soon as the sun became lower and the air began to chill. This did happen, and we reached the summit at 5 p.m. under beautiful conditions with scarcely a cloud anywhere. The temperature on top was a little below zero, with a gusty 35-mile west-southwest breeze. The temperature at the base of McKinley at the same time was nearly 80° above zero, on one of the hottest days of the summer.

McKinley is probably one of the coldest and most savage spots on earth. It is a subarctic mountain (63° 04′ north latitude), with an annual precipitation on its upper slopes that must have well over 100 inches of water content, resulting in tremendous snowcover and great glaciers.

Most rules have their exceptions, of course, and I shall never forget three glorious hours spent atop McKinley's 19,440-foot north peak on June 7, 1947. We surveyed there from 2 until after 5 o'clock in the afternoon in the warm (−8°) sun without a breath of wind and almost cloudless skies — so calm was it that the pages of our angle book did not even waver as it lay open beneath the tripod during lunch!

Although its low temperatures are probably rarely, if ever, as extreme as certain of the isolated record-breaking spots in the arctic or antarctic lowlands, McKinley never gets nearly as warm as they do during the summer months. Our minimum-registering thermometer left at Denali Pass from 1947 to 1951 registered only −59° F. as the minimum for that period. However, the temperature atop its peak is rarely above zero, even in midsummer, and its year-round average must be one of the lowest to be found anywhere on earth.

Hudson Stuck's minimum-registering thermometer left at Parker Pass (altitude 14,600 feet) in 1913 showed a 19-year minimum of somewhat below −90° F. when recovered by the Lindley-Liek expedition of 1932, but there is some question as to whether the location of the thermometer and the way it was placed in the rocks did not permit slight vibration of the instrument. Our thermometer at Denali Pass was very heavily weighted with rocks and could not possibly have been affected by wind vibration. Mt. McKinley, however, lies in a very active earthquake zone, and it is doubtful if thermometers left for any great length of time on the mountain would give accurate minimum temperature records unless they were of the bimetallic type.

Massive snow blocks photographed in April, 1945, at an altitude of 9,000 feet on Mt. Silverthrone (13,230-foot summit), about 15 miles to the east of Mt. McKinley. These columns are about 70 feet thick and show about 10 years of compacted snowfalls, the lower layers being compressed almost as hard as ice. The scale of the scene is indicated by the climber in the lower right.

Weather can be a powerful factor in the success or failure of any expedition to a peak higher than 15,000 feet situated in any latitude. If one learns the local phenomena and watches their development closely, a knowledge of the weather can prove a highly valuable asset — one which is often essential to success, as we have learned from experience on Mt. McKinley.

CIRRUS

R. D. FLETCHER
AND
CAPT. DOYNE SARTOR
HEADQUARTERS, AIR WEATHER SERVICE

THE FILMY gauze-like cirrus clouds, on which the sun paints its colorful sunsets, are in general misleading to the observer on the ground who attempts to report their dimensions and character. As greater altitudes are being reached by newer aircraft, more and more pilot reports of the height, extent, and the restriction to visibility of cirrus clouds are becoming available. According to the Air Weather Service personnel at Wichita, these pilot observations are in general agreement that cirrus cloud estimates made by observers on the ground are inadequate for describing the visibility-reducing phenomena actually encountered. It is generally reported by the pilots, for instance, that:

1. Cirrus is more frequently encountered and more extensive than would be supposed from surface observations. With a surface report of one- or two-tenths cirrus coverage, it is by no means uncommon for a pilot to report that he has been flying in or above an overcast cirrus layer.

2. Cirrus is thicker than might be guessed from surface observations; thicknesses are frequently greater than 6,000 feet and occasionally exceed 10,000 feet.

3. Cirrus cloud bases more often than not are higher than the bases estimated by observers on the ground, sometimes by several thousands of feet. One pilot has reported a discrepancy of 17,000 feet between an encountered base and the base estimated by a trained observer at a sea-level station.

4. In the upper troposphere there frequently exist haze layers which are not evident from the ground observations, and which do not appear to be in the nature of ordinary cirrus clouds. They effectively reduce horizontal visibility, but are less effective in reducing visibility downwards.

The bases of cirrus layers are often described as being less well defined than are the tops, and this description is applied quite generally to haze layers. Some pilots report that the tops of such phenomena frequently coincide with temperature inversion bases. Although excellent horizontal visibilities are attributed to the air above the tops, downward slant and vertical visibilities partially depend upon the position of the pilot relative to the sun.

On occasion, the effect of sunlight and shadow on cirrus can be seen by the ground observer when the sun is near the horizon. When towering cumulus near the horizon between the observer and the sun appear in combination with broken or overcast cirrus, streaks of shadow often fall on the higher cloud in such a manner that no cirrus will be observed within the shadow zones. The outlines of the shadows clearly mark the boundary between cirrus and what appears to be blue sky. After the sun has set or before the sun rises, when the cirrus is in the shadow of the earth, the sky appears entirely clear of such clouds. This apparent change in amount can be noted almost any time after the sun sets or rises with cirrus in the sky. The change is so gradual, however, that without cloud shadows for comparison, it is usually difficult to determine whether the cirrus is

forming or dissipating, or whether it is merely becoming more or less visible.

In the studies reported here no attempt is made to differentiate between the various types of cirrus. Many varieties are observed, of course, and one can speculate as to the effect of each on a flight mission. For instance, tops are probably better defined, and reflected sun glare from the tops is probably more pronounced, with cirrostratus than with patchy cirrus or cirrocumulus. Again, certain cirrus forms suggest the presence of small-scale wind currents or eddies inside the clouded layers. Several encounters of marked turbulence within cirrus clouds have been noted by pilots.

The picture on page 8 is an excellent illustration of eddies in cirrus clouds. The upwardly curved wisps of cirrus, appearing roughly on a line extending diagonally from the upper left to the lower right of the photograph, trace out eddies which have considerable vertical dimension in the upper atmosphere, an indication of possible turbulence at extreme heights as well as of the vertical extent of some cirrus.

Statistics on vertical cirrus dimensions are very sparse. Weather personnel at Rapid City, South Dakota, however, have tabulated a limited set of height measurements, of which summaries are given in the following paragraphs. The data result from encounters of aircraft with cirrus layers and were gathered by trained observers. They are limited almost exclusively to the winter and early spring seasons, although most sections of the United States are represented.

In Fig. 1 are plotted the observations of cirrus-top heights as a function of latitude. When the aircraft passed through several cirrus layers, only the top of the highest layer was plotted. The tendency is the same as in Fig. 2, with considerable scattering.

It was found that cirrus ceilings vary inversely with latitude. The scattering about the average is large. Fig. 2 contains a plot of the data, only the base of the lowest layer being given in cases in which the aircraft encountered multiple layers. Attempts are now being made to relate the scattering of data with proximity to such atmospheric features as the jet stream and the tropopause.

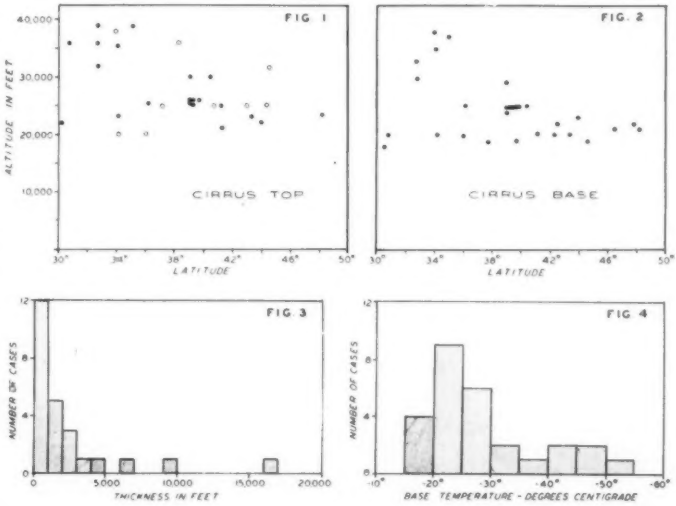
Fig. 3 shows the frequencies (numbers of cases) of various thickness ranges of cirrus clouds for the few samples available. For the same samples, Fig. 4 shows the frequencies of various temperature ranges at the cloud bases.

The observations presented in this article may be of assistance to the observer in obtaining more accurate observations of cirrus from the ground. Cirrus, which may be difficult to detect from the ground, especially at night, can present a formidable visibility problem to a high-flying aircraft. Because of the conservative nature of cirrus, accurate observations of existing cirrus are extremely valuable to the cloud forecaster.

Figs. 1 and 2 show how the levels of cirrus tops and bases vary with latitude. In Fig. 1, the position of an aircraft within a cloud whose top is not known is denoted by an open circle.

Fig. 3 shows the frequency of cirrus thicknesses by thousand-foot intervals.

Fig. 4 shows the frequency of base temperatures of cirrus clouds plotted for five-degree intervals.



A scene at Nashville, Tennessee, after the ice on the ground had been covered with snow, February 1, 1951. Photograph by Henry Schofield Studio.

The Great Southern Glaze Storm of 1951

BEN W. HARLIN, U. S. WEATHER BUREAU, NASHVILLE, TENNESSEE

DURING THE CLOSING DAYS of January, 1951, one of the most destructive storms in history enveloped the upper and middle South in a great sheath of ice that extended in a strip more than 100 miles wide from Louisiana northeastward to West Virginia. It was the costliest winter storm on record for the southeastern states, and the estimated $100,000,000 damage exceeded all other single storm damage for the region, with the possible exception of hurricane destruction at coastal points.

The glaze storm was associated with a great outbreak of polar air that swept into the central part of the United States from the Canadian arctic during the last week of January. Over the southeastern states the polar air met its first resistance in the form of a tropical air mass from the Gulf of Mexico. These two conflicting air masses were to make meteorological history in many areas, but it was the Southland that suffered most in human misery and property damage.

The scene was set in middle January as a series of Pacific lows moved inland just to the north of Oregon and Washington, while a great high pressure area with a vast reservoir of frigid air remained stationary over Alaska and western Canada. The high began to intensify on January 22nd, building to near record intensity — there were map reports of 1062-mb readings. On January 25th, a rapidly moving low crossed the Pacific coastline and disappeared over the plateau, but another low formed on the front in Nebraska and sped eastward to Ohio in the next 24 hours, with frigid air sweeping down behind it over the plains states to central Texas.

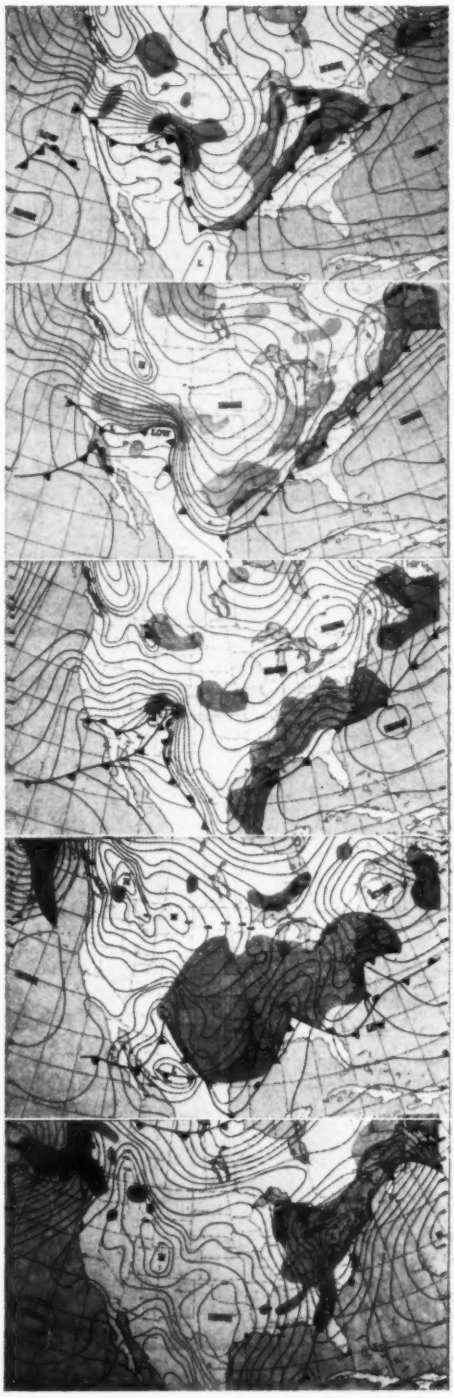
On January 29th a large 1041-mb high was

centered over Nebraska and Iowa. The cold front with several waves along its leading edge had reached the Atlantic Coast, but extended inland over Virginia through the middle South to the western Gulf of Mexico. Some freezing rain, sleet, and snow occurred behind this front as it moved steadily southeastward on the 28th, 29th, and 30th, causing accumulations of ice on trees and wires and a covering of about two inches of mixed sleet and snow on the ground.

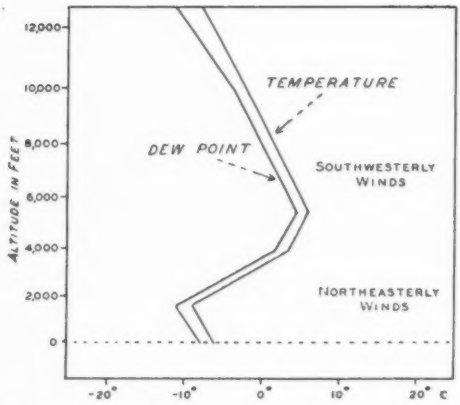
During the forenoon of the 29th, another Pacific low, that was responsible for the final plunge of cold air into the Southeast two days later, moved in over southern California, and in 24 hours had joined with another low which was moving slowly southeastward toward the Gulf. When the trough aloft associated with this disturbance reached the Texas area, a new low developed over the warm waters of the Gulf that was to cause millions of dollars of damage.

On January 31st the Gulf low deepened and commenced a rapid journey northeastward as a wave along the major cold front, reaching Pennsylvania by noon the next day. Light to moderate sleet and freezing rain occurred ahead of the low, but soon changed to snow as the winds shifted to west and northwest, with falls being reported as far south as Burrwood, Louisiana, at the mouth of the Mississippi, and at Daytona Beach in central Florida.

The situation on the 31st was further complicated by an upper cold front that entered the region near noon and moved across the Gulf states during the afternoon as sleet and freezing rain were falling. The upper front's approach to the surface front, with the latter's overrunning warm, moist air, triggered a series of unusual thunderstorms on a line from Kinder, Louisiana, northeastward to Greenwood, Mississippi. The intensity of the precipitation increased rapidly, and the high winds that developed in the thunderstorms sent ice-laden limbs, trees, wires, and poles crashing to the ground. Similar damage occurred in northern Alabama, a large portion of the damage to trees and communications



The surface weather maps for 12:30 p.m. CST, January 28, 1951, to February 1, 1951 (top to bottom). The areas of precipitation are shaded, portions of the southeastern states being included in each case. USWB charts.



A sounding made by rawinsonde at Nashville at 2100 CST, January 30, 1951. Note the below freezing temperatures near the surface, with northeast winds, and the above freezing temperatures above 3,000 feet, with southwest winds. Data from U. S. Weather Bureau.

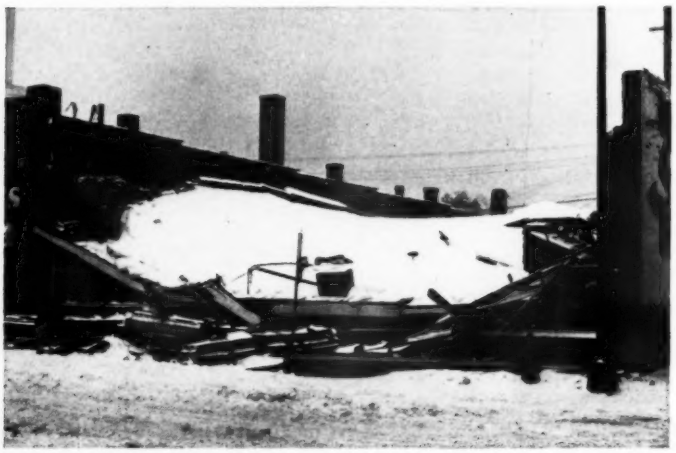
resulting from this unusual combination of high winds following severe glaze. The total precipitation at many points was more than five inches of water.

Farther north over western and central Tennessee, Kentucky, and parts of West Virginia, light to moderate sleet and freezing rain occurred all day and lasted until past midnight. By the afternoon of the 31st the accumulation of rain-soaked sleet on the ground was making travel difficult, even on frequented highways and streets. Many breaks occurred in power and communication lines, so telephones, radios, furnaces, and electric ranges became inoperative. New homes, equipped for electric heat only, were thus rendered uninhabitable. Families whose homes still had stoves or fireplaces were among the fortunate, as resort was made to pioneer methods for cooking and heating.

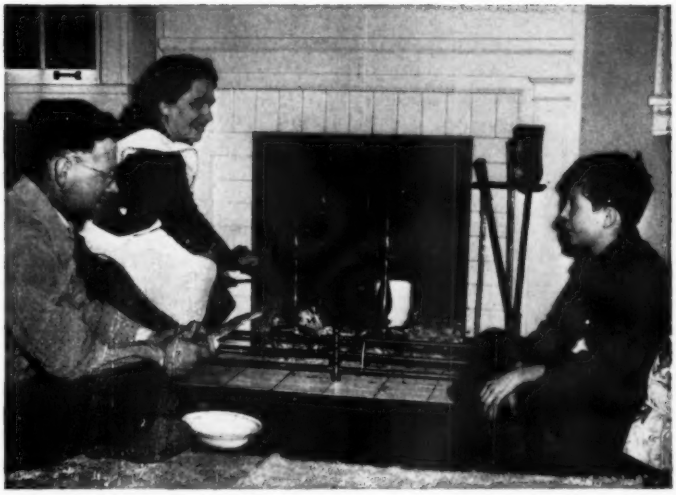
The Nashville *Tennessean*, in an article by H. B. Tetter carried on February 11th, stated: "Never before in recorded history did winter hit this area with such devastating force to paralyze the everyday life of the community. Never before were so many homes plunged into frigid darkness. Never before were so many faced with hardship and suffering in what was once the security of home, and never before were the complex transportation systems of the area held immovable for such an extended period. The great storm of ice, sleet, and snow struck hardest at Nashville on the morning of February 1, 1951. Ten days later life had not resumed normal activity."

With eight inches of frozen precipitation on the ground by the morning of February 1st, traffic was practically paralyzed in central Tennessee and remained so for three days. Some vehicles with chains were able to move, but their progress was hampered by stalled and abandoned automobiles. Many tourists were stranded for four or five days.

The explanation of the difficult travel conditions lies in the fact that the four to five inches of water-soaked sleet on the ground was at first not frozen into a solid sheet. This layer was then covered with three to four inches of dry snow, and with falling tem-



Ice and snow with five inches of water content proved too much for this roof of a Nashville building. Photograph by Henry Schofield Studio.



Among those forced to resort to primitive methods of cooking, as electrical power failed in Nashville, were Mr. and Mrs. Douglas Roach and their son, Douglas, Jr. Photograph by Bill Preston, courtesy Nashville *Tennessean*.

peratures the mass began to freeze at the top. The snow and sleet would not pack under the weight of vehicles, and the wheels would sink down to the wet pavement and spin. Before roads and streets could be scraped, the sleety mass next to the ground froze into a solid sheet of ice about four inches thick with the dry snow still on top. Three or four days later, after daytime melting of the snow layer and nighttime freezing, the entire covering on the ground became a semitransparent layer of solid ice.

The human toll was great; about 25 persons lost their lives and over 500 were injured through storm-induced accidents. The total storm damage was estimated by the U. S. Weather Bureau to reach approximately 100 million dollars, broken down as follows: forests, 56 million; communications and power lines, 10 million; highways and streets, 15 million; fruit and nut trees, four million; buildings and plumbing, 4.3 million; livestock, three million; truck and grain crops, 1.6 million; and several millions for losses to transportation and business.

The glaze storm of 1951 and the weather events of the following week will long be remembered in the South, since there has been only one other parallel instance in recorded Weather Bureau history. In February, 1899, another similar outbreak of polar air engulfed the entire region, bringing below-zero temperatures and deep snow to extreme southern limits, but there was one fundamental difference between these outbreaks. In 1899, the culprit low formed in the Gulf near Mobile, Alabama, much farther to the east than in 1951. This permitted a deeper penetration of cold, and heavy snows instead of sleet and glaze covered most areas, a condition that is less paralyzing to the life of a modern urban and industrial community. In all, the storm of 1951 was a major disaster for the middle and upper South and appears to have been the costliest ice storm on record.

NEW AVIATION FORECAST SERVICE

An aviation weather forecast by short-wave radio has been started by the Weather Bureau in New York City to assist private flyers. The service, reportedly the first of its kind in this country, will cover the area bounded by Boston, Albany, Harrisburg, and Washington.

The broadcasts will be on the air from 6:00 a.m. to 6:00 p.m. daily. Each forecast will take from three to seven minutes and will be amended hourly. Tape recordings will be used. The information will be transmitted from LaGuardia Field on a frequency of 173.975 megacycles, and then will be retransmitted by automatic pickup at the downtown Weather Bureau office on 162.55 megacycles. The call letters of the new station are KWO35. Amateur weathermen can tune in on these frequencies with the new-type civil defense radiophone receivers or very-high-frequency aircraft receivers.

Telecasting the Weather

CLINT YOULE

Clint Youle, a Chicago weatherman, as he appeared before the cameras on one of his early television broadcasts. WNBQ photo.

A COUPLE OF YEARS AGO a Chicago newspaper asked for a piece on the private life of a television weatherman. As I remember it, my answer mentioned strongly the need for an adequate disguise. Uncle Sam's big city forecasters usually are tucked away in some cramped corner where their closest contact with the ordinary citizen is by telephone. TV weathermen, however, quickly become part of the local scene. They are easily recognized, and the legitimate object of every man's scorn, anger, or jest.

There are, of course, great compensations. One develops tremendous mental agility and the ability to remember facts quickly. Wake any forecaster in the middle of the night, and before you've taken your hand off his shoulder, he'll be saying authoritatively: "dew point in Old Hamswich, 40; in Dry Bone, zero." But wake a TV forecaster, and he'll look you in the eye while explaining that he by no means spoke categorically yesterday when he referred to clear skies — the rain that fell by the ton was the alternate forecast.

Since television appears to be settling down upon us permanently, perhaps we had better examine the still unsettled relationship it has to reporting the weather. Some of the things I've learned in three years before the cameras might be of interest to others considering a move out into the direct line of fire. Here's what I've been putting into 10 minutes.

First, and most obviously, all the available facts: high and low temperatures for the 24-hour period; precipitation amount and its relationship to normal; maximum wind speed; barometric pressure and trend. These are generally printed on a large sheet of paper while "on camera." They give action to what otherwise would be merely talk. And any considerable deviation from normal in any of the facts provides material for extra comment and comparison.

The day's statistics lead naturally into a discussion of the day's weather, the why of the current clouds, snow, heat, or falling barometer. From the local weather, it's a natural step to the overall weather picture throughout the country. Occasionally, I refer to lows and highs; much more often I refer to small, medium, large, or potential storm centers, and masses of warm, hot, or cold air from the Pacific, the southwestern states, or from northwestern Canada. Laymen seem particularly interested in the recent source of their weather.

I presume that most meteorologists would agree that there is more than one forecast possible for any given location at any given time. On days when the chances for a miss are great, I try to show the public the alternate possibilities, the reasons for the alternatives, and the reasons for selecting the one finally chosen. This serves a double purpose. It graphically demonstrates the difficulties

faced by any forecaster, and it makes the viewer much more tolerant of a missed forecast. He's been prepared in advance, and feels as though he himself had participated in the decision and so is partly responsible for its error.

Speaking of missed forecasts, it seems best to admit a failure promptly, then show exactly what happened to cause it. Mail comments on this procedure have been uniformly approving, and a number of viewers have written to say that these explanations, for the first time, have given them an understanding of the problems faced daily by the Weather Bureau. The explanations of misses and the presentation of alternate forecasts are also valuable in providing the viewer with conversation material. Frequently we overhear people on trains, in elevators, and at gatherings explaining in detail to non-viewers just why our January temperature jumped to 65° instead of dropping for a cold wave. People enjoy having extra knowledge, particularly if they can acquire it painlessly and pass it on readily.

This same providing of extra information is the main reason for adding details about weather phenomena, no matter where they occur. If there are winds of 55 miles an hour and blowing dust in Tucumcari, I mention it; and the same goes for hailstones in South Dakota; 40° below zero at Cutbank, or 114° at Yuma. Tornadoes, hurricanes, and violent thunderstorms are, of course, a part of any telecast near the time of occurrence; having been a news editor for 10 years, I know that such items are weather news of top rank.

At frequent intervals, too, I give temperatures or precipitation figures from all sections of the country. That's partly the result of letters from viewers. A steady stream of mail comes from people who formerly lived in New England and want to know about the weather back home; from people whose sons are in the army in Texas or California; from those whose relatives are snowed in at Double Peak, Colorado; from many who plan next year to visit the New Mexican caverns and want to be posted in advance on the local weather. Apparently, a majority of the viewers are interested in their local weather first, their fellow citizens' weather second.

Human nature provides another reason for telling weather outside the local area. A man who's been grumbling in Chicago over shoveling six inches of snow seems to be comforted a bit to learn that Duluth has 24 inches of snow and more falling. Or, in summer the tired and hot Chicago housewife feels a bit more cheerful when she learns that Dallas has just had its tenth straight day of 100-degree temperatures.

Then there are the folks with special interests dependent upon weather — the skiers, the flyers, the fishermen, the golfers, the picnickers, transportation agencies, and so forth. In season, I try to provide a generalized forecast for them, relating it to their specific activities.

In presenting the weather to an audience composed largely of non-meteorologists, I oversimplify explanations at times. I use diagrams whenever possible, sketching them while "on camera." I stay away from technical terms, preferring to be not quite accurate in language rather than bury the audience with words that are meaningless to them. I draw fronts and storms and place temperatures freehand on the map, giving approximations rather than pinpoints, in an effort to keep the show moving.

Of course, the basic ingredient needed for a weather program on radio and television is the aid, information, forecasts, and comfort furnished by the United States Weather Bureau. The bureau office in Chicago has been the main prop and provider for me. Its members, from Gordon Dunn and his regional and airway forecasters right on to the newest map plotter, have gone out of their way to be helpful. They've discussed and explained and watched for features I'd never have seen.

Mail from the TV and radio programs presents quite a task. Roughly speaking, 75 per cent of it is complimentary; 20 per cent is seeking climatological information or impossible advance forecasts; four per cent is miscellaneous, from people wanting to know how to ward off thunderstorms or whether TV aerials are causing excess rainfall. One letter out of a hundred is harshly critical — and almost invariably anonymous.

As long as the ratio stays like that, I won't be concerned; so long as people watch, the program is performing its function. In any case, it's fun, and I'm enjoying doing it.

Fig. 1. The original shelter, in a location which in 21 years has become heavily shaded. Seabrook Farms photographs.

The Effect of Natural Shading on Temperature Measurements

MAJOR P. M. FLOYD, JR., USAF
LABORATORY OF CLIMATOLOGY
JOHNS HOPKINS UNIVERSITY

INSTRUCTIONS to weather observers emphasize the importance of proper exposure of instruments. It is normally recommended that an instrument shelter be installed at an exposed location on a grassy plot. Sometimes it is inconvenient to place the shelter at an ideal location. What, for example, is the effect on temperatures if the shelter is shaded?

Even though the shelter is painted white, it is far from a perfect radiation shield. When exposed to the direct rays of the sun, the shelter absorbs heat until temperatures as much as four degrees too high are attained. On clear, calm nights the shelter loses heat by radiation until the resulting temperatures are slightly lower than those of the surrounding air.

In 1949, when the microclimatic network of the Johns Hopkins University Laboratory of Climatology was established in southern New Jersey (WEATHERWISE, April, 1951, page 27), it was discovered that mean temperatures at the station located in the garden of Bennett K. Matlack, Bridgeton, N. J., were consistently warmer than those of other observing stations located only a few miles away. The Bridgeton station is the oldest in the network, having been maintained in its present location by Mr. Matlack, a co-operative observer for the U. S. Weather Bureau, for the past 21 years.

Over the years a lilac bush and rows of trees have grown up along the east and south sides of the shelter, thus shading it during most of the day (Fig. 1). To determine whether or not the warmer temperatures were caused by some peculiarity of the exposure, a second shelter was installed at an exposed location 50 yards from the shaded station (Fig. 2). The slope of the land between the two shelters was negligible, and a similar grassy surface existed beneath each. Daily maximum and minimum temperatures were recorded at the two stations for a 21-month period, July, 1949, through March, 1951. The experiment was discontinued when the owner of the garden requested that the exposed shelter be moved to make way for an asparagus bed.

Fig. 2. The location of the new shelter.

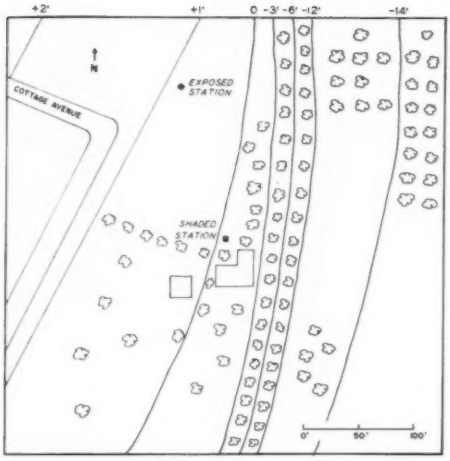


Fig. 3. The shelters and the local topography, with contour lines in feet.

The mean temperature for the 21 months for the shaded station was 53.8° F. and for the exposed station 54.4° F. Thus the exposed station averaged 0.6° F. warmer than the shaded one, and the temperature excess of the station in Bridgeton is apparently a real one. The ground slopes sharply downward to the east and slightly upward to the west of Mr. Matlack's station, as shown in Fig. 3. Drainage of cold air down the slope at night causes higher minimum temperatures near the top of the slope.

As shown by Fig. 4, in general the maximum temperature was higher, and the minimum temperature lower, at the exposed location. Maximum temperatures differed more than minimum temperatures. Differences were greater in clear weather than when the sky was overcast. The effect of shading was much less in winter when the bushes and trees were without leaves. The effect of shading on the daily range of temperature was much more noticeable than the change in the mean temperature.

The curves in Fig. 4 indicate that the maximum differences between the stations occurred in August and September rather than in July. This can probably be attributed to decreased cloudiness in late summer. Also the increasing dryness of the soil may have been a contributing factor.

This article was prepared as part of the author's work as a graduate student in micrometeorology, under U. S. Air Force sponsorship, but the views of the author do not necessarily reflect those of the Air Force.

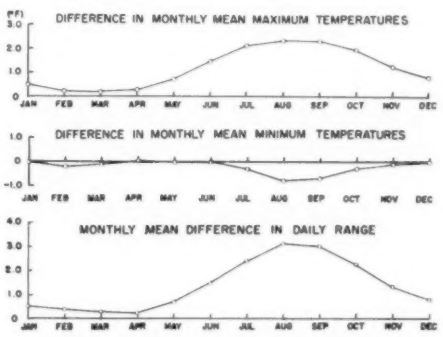


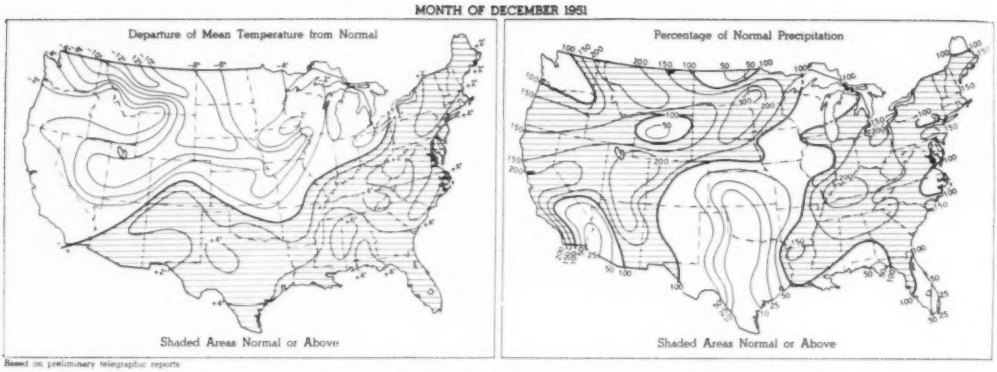
Fig. 4. Means of temperature differences.

RADAR RANGE VARIES WITH THE WEATHER

Radar range for ship-borne equipment on vessels operating on the Great Lakes becomes from 10 to 15 times greater than normal under special atmospheric conditions, according to studies being carried out by the Canadian National Research Council, and reported by Science Service. Conditions of abnormal propagation were first noticed during World War II, when unusual radar range was occasionally achieved by coastal radar.

The recent studies were made on Lake Ontario, where the special conditions that increase radar range are quite common on fine summer days. On these days a layer of air from 50 to 200 feet thick forms above the surface of the water, and serves as a duct to trap and contain the energy transmitted by the radar. It is generally thought that a humidity inversion is formed in this layer and serves to guide the radar beam along the surface far beyond the optical horizon.

In studies now being made, a typical marine radar is mounted in a cage which travels slowly up and down a cable from the top of a Lake Ontario bluff to the water level. A photograph of the radar screen is taken automatically every 30 seconds. This gives a record of radar performances under prevailing weather conditions for all radar heights from 10 feet above water to 250 feet above.


MONTH OF DECEMBER 1951
Departure of Mean Temperature from Normal
Shaded Areas Normal or Above
Percentage of Normal Precipitation
Shaded Areas Normal or Above
Based on preliminary telegraphic reports

U. S. Weather Bureau charts of departures from normal of temperature and precipitation.

DECEMBER, 1951, BRINGS WINTER AND SUMMER

OLD MAN WINTER made an unusually early visitation in November, 1951, as already described in this magazine (page 131, December, 1951). A strong upper-air ridge of high pressure over the Pacific and plateau states, in conjunction with a deep trough of low pressure aloft extending from Hudson Bay southward into the central United States, permitted successive surges of cold air to flow southeastward out of the Canadian arctic, which had experienced much below normal temperatures for a month previously.

After the 10th of November, a weakening of the Pacific ridge took place, and the upper-air flow became more westerly, with milder Pacific air replacing the flow from the northwest. This lasted until the closing week of the month, when a western ridge and eastern trough pattern again was established, but with less extreme results than occurred earlier. The November precipitation pattern was very uneven, heavy amounts occurring along the principal storm track from Oklahoma to the lower Great Lakes, and also along the Atlantic Coast because of secondary storm developments.

December was a very active meteorological month. Weather fans, regardless of their predilections, could find much to interest them in the great variety of weather events. Once again the first 10 days exhibited a circulation pattern quite different from that of the second and third decades of the month, but this time the roles were reversed.

A high westerly index of upper-air winds prevailed during the first decade, with the principal storminess concentrated on the Pacific Coast where a series of North Pacific type lows moved inland, each one crossing the coastline a bit farther south than its predecessor. E. L. Felton, meteorologist in charge at the Weather Bureau in San Francisco, has kindly sent this report to WEATHERWISE, dated December 11, 1951:

"San Francisco was subjected to a series of three storms in rapid succession during the period November 30 through December 5, 1951.

"The first of these produced 2.19 inches of rain. Very heavy rain occurred on the morning of December 1st, with maximum intensity of 0.37 inch during one 15-minute period. The lowest pressure for this storm was 29.72 inches, which occurred at 1:00 p.m. of the 1st, and strong to gale force westerly winds accompanied the rise in pressure during the afternoon and evening. The fastest mile was 42 miles per hour at the USWB office in the civic center, but gusts reaching 60 miles per hour were observed at the towers of the Golden Gate bridge. Vertical whipping and sidesway of the bridge structure during the height of the storm caused bridge officials to close the bridge to traffic for three hours.

"The second storm began late in the evening of December 2nd, and had a lowest pressure of 29.80 inches at 8:00 a.m. on the 3rd. Total precipitation was 1.63 inches, maximum intensity 0.18 inch for one 15-minute period. Winds reached 29 miles per hour.

"The third and final storm began during the early morning of December 4th, reaching a minimum pressure of 29.76 inches at 11:00 a.m. The total rain was 0.75 inch, maximum intensity 0.14 inch for a 15-minute period. Winds were occasionally strong, with 29 miles per hour the highest velocity recorded at the USWB office.

"Thus, the three closely associated storms produced 4.57 inches of rain at San Francisco and caused many local floods in the surrounding areas."

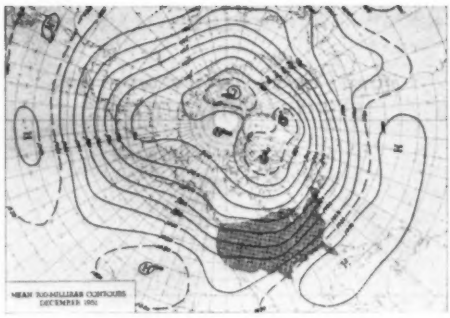
With the flow of polar air cut off by the westerly circulation, the East and South basked in temperatures far above normal. The heat progressed eastward: at Devil's Lake, North Dakota, the week ending December 4th was 18° F. above normal, while for the following

week at Washington, D. C., and Richmond, Virginia, it was also +18° F. A strong southwesterly flow aloft over most of the United States aided high surface winds that stirred up a three-day dust storm in western Texas, with the worst damage around Lubbock, where only 1/100 inch of rain had fallen since October 3rd. A tornado ripped through part of New Orleans on the 5th, when a very warm and moist air mass occupied that area.

Near record December maximum temperatures occurred on the 7th at such places as: Philadelphia, 72°; Elkins, 76°; Norfolk, 77°; Birmingham, 80°; Charleston, 81°; and Tampa, 85°. This warm regime was not routed until the 10th, when a cold front from the northwest, the harbinger of many more to come, penetrated all the way to the Atlantic and Gulf coasts.

While it was warm in the East, the Great Basin and Pacific Coast were locked in a severe cold spell. Freezing reached to the coastline in southern California as a 1044-mb high in Utah pushed cold air through the mountain passes; there was some damage to citrus crops. San Francisco registered 32°, Santa Maria 29°, and Burbank 33°. An extensive snowcover helped Ely, Nevada, to have −22° and northern Arizona −17° on the 9th. Nevada temperatures averaged 18° below normal, while Washington, D. C., had 18° above normal, a situation that has been commonplace during the past three winters.

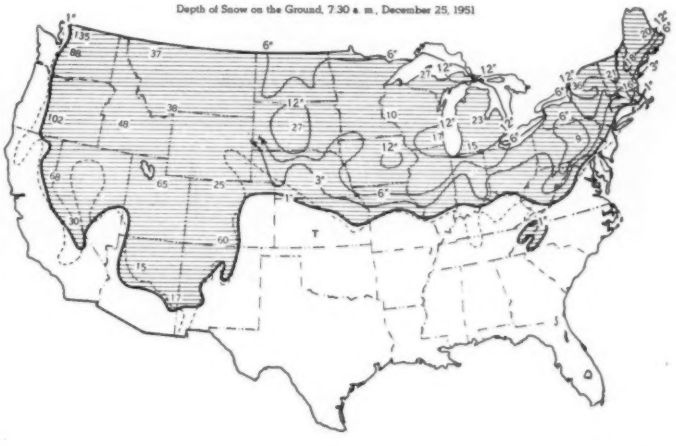
On December 10th the Pacific ridge began to make itself felt; a strong surface high put in an appearance over the Great Basin, and pressure began to build over Alaska, the signal that a low westerly index was about to take over. This marked the beginning of a second and much more prolonged visit from winter. A low aloft took form over Hudson Bay with a trough extending southwestward over the Great Lakes and Mississippi Valley, much the same as early in November. This trough provided an excellent storm track for four distinct depressions that were to make up and sweep across the central and northeastern United States during the next two weeks. Each storm was born in the Colorado-Texas Panhandle area and was in progress across the country on the following dates: **A,** 13-15; **B,** 17-18; **C,** 19-22; **D,** 24-26. Each moved northeastward at a rather good pace, generally along the Oklahoma City-St. Louis-Pittsburgh-Burlington axis, accompanied by moderate to heavy rain to the south of the track and by heavy snow, sleet, and glaze to the north.



The mean 700-mb chart for December, 1951, with the United States indicated by shading.

Since the paths of the storms were somewhat south of the normal seasonal tracks up the St. Lawrence Valley, northern New York State and New England, which had experienced a snow famine for the past three years, received welcome early season falls to encourage hydrologic engineers and to cheer winter sports enthusiasts.

Watertown snow. The fall and early winter are usually the snowiest period at Watertown, New York, at the eastern end of Lake Ontario. This was, however, the snowiest early season since 1900 and the third snowiest on record,



Two thirds of the country had a white Christmas in 1951. Depths were generally 12 inches or more in the North, from South Dakota to Maine. The shaded portion of the chart shows areas covered with snow, and contour lines indicate depths in inches. From the *Weekly Weather and Crop Bulletin,* courtesy USWB.

with a total of 86 inches measured by R. Davison, the co-operative observer. The November fall totaled 12.4 inches, but the real snow season began on December 12th, as his records show:

Dec.	Fall	Depth	Dec.	Fall	Depth
12	0.7	1	22	0.5	14
13	1.2	2	23	8.2	19
14	—	2	24	3.9	21
15	5.9	6	25	4.2	24
16	T	5	26	4.6	25
17	34.0	34	27	0.3	24
18	4.7	28	28	T	22
19	4.8	22	29	0.2	19
20	—	20	30	—	13
21	0.4	14	31	—	11

The total snowfall in 20 days was 73.6 inches.

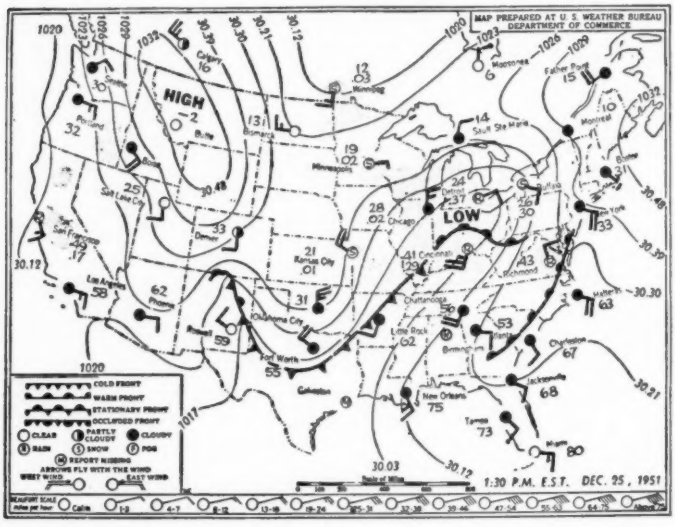
Chicago snow. The early November storms had left Chicago with a total of 14.3 inches, the second highest on record. No more appreciable amounts fell until December 14th, when a series of lows hit the windy city and deposited a total of 33.3 inches, as reported by R. E. Lautzenhiser, Chicago climatologist:

Dec.	Precip.	Snowfall	Depth
14	.48	10.0	10
15	—	—	9
16	—	—	7
17	.38	4.6	9
18	.23	2.8	12
19	.04	.6	8
20	.53	5.2	11
21	.13	1.5	12
22	—	—	10
23	—	—	9
24	.32	4.6	10
25	.32	4.0	17

On the day after Christmas, an upper low appeared off the Oregon coast, with a trough northeastward to Hudson Bay, putting the air flow back to that which had prevailed during the first few days of the month. High westerly index was restored, and low temperatures were restricted to the northwestern part of the country from Minnesota to the Pacific Coast (Great Falls, Montana, averaged 23° below the normal for the last week of December). The southwesterly flow brought eight consecutive rainy days to San Francisco, with a total of 2.64 inches. Inland, heavy snows fell in the mountains and tied up the holiday traffic, presaging more serious things to come, when new storms in January would dump heavy amounts on the existing snowcover. In Colorado and Utah snowfalls were called "phenomenal" by the press.

Elsewhere, mild conditions prevailed until the last day of the year. In the East and South it was one of the mildest late December periods ever experienced, as these maximum temperatures show: December 30, Dodge City, 72°; Shreveport, 83°; Ft. Worth, 90°; December 31, Wichita, 70°; Evansville, 75°; Huntington, 77°; Montgomery, 81°; Abilene, 85°. Snowcover farther north kept temperatures down, but heavy advective fogs developed to disrupt both surface and air transportation over the long holiday weekend.

The abnormal warmth reflected the upper-air situation, where a large, deep low over northern Canada dominated the weather of the entire continent. By the 31st, this regime began to break down, as the month's fifth Colorado-type low moved northeastward. At midnight of New Year's Eve, the associated cold front extended from Lake Huron to Oklahoma, and some remarkable temperature contrasts were observed: Ft. Smith, Arkansas, 73°; Oklahoma City, 29°; Valentine, Nebraska, −8°; Indianapolis, 67°; St. Paul, 0°; Havre, Montana, −25°. D. M. L.



The surface weather chart for Christmas Day, which shows a large low pressure area centered over Indiana and Ohio, with associated precipitation occurring over all of the East before the day ended. The Rockies and Far West had crisp, seasonal weather. USWB chart.

INTRODUCTION TO PHYSICAL METEOROLOGY

Hans Neuberger. The Pennsylvania State College, State College, Pa., 1951. 271 pages. $3.50.

HAVE you ever wondered how artificial rain, which has come in for so much publicity lately, is produced? What makes the stars twinkle? What causes a mirage? How do visibility meters work? What is the temperature distribution in the stratosphere? How fast does lightning travel? You'll find the answers to these and a great many more questions in this book.

As the title implies, it is written on an intermediate level which might make it a suitable text for a first college course, as well as the text of a correspondence course for which it was written. There is a complete absence of higher mathematics, and no more than a first course in physics is necessary for ease in reading this book, since the development of each topic is more descriptive than theoretical.

The material is well organized into the conventional groups. Chapter 1 deals with condensation processes in the atmosphere, and includes material on artificial production of precipitation, and aircraft icing. Chapter 2 deals with visibility — the most complete treatment this reviewer has seen in book form. The actual physiological make-up of the eye is described, and the effect of psychophysical factors on the performance of the eye and their influence on the objectivity of visibility observations are treated. Also included are the basic principles on which various types of visibility-measuring instruments are constructed. Chapter 3 is a standard treatment of solar and terrestrial radiation.

Chapter 4 deals with meteorological acoustics, and includes a section on the anomalous propagation of sound and its application to the study of the stratosphere. The last part of the chapter describes sounds caused by the weather elements. Chapter 5 concerns itself with meteorological optics, and has a good description of the apparent shape of the sky as well as such commonly observed phenomena as scintillation, halos, rainbows, and sky color.

The final chapter is titled "Atmospheric Electricity." The reader will find here the theory of ions, their formation, existence, and measurement in the atmosphere. Hypotheses are presented for the maintenance of the earth's negative charge. Special electrical phenomena are described, such as St. Elmo's fire, aurorae, and lightning. Especially good are up-to-date discussions of lightning mechanism and the application of radar observations to meteorology.

For purely descriptive material on the application of physical principles to meteorology this book could serve as a valuable reference. It contains many facts and much data which this reviewer has not seen elsewhere in such handy reference form, and it includes the results of very recent work in such fields as condensation processes, radar, stratospheric temperatures, and atmospheric electricity.

FRANCIS K. DAVIS, JR.
Drexel Institute of Technology

EXTENDED FORECASTS

WEATHER FANS are missing a good bet if they do not receive the **Average Monthly Weather Resume and Outlook** that is published by the Weather Bureau twice a month. Many are familiar with the brief excerpts of this publication that appear twice monthly in the nation's press and always draw considerable attention, since they give us our best outlook as to the next 30 days' weather prospects.

The **Resume and Outlook** is now in its sixth volume under the able editorship of Dr. Jerome Namias, chief of the Extended Forecast Section of the Weather Bureau in Washington. This publication was formerly restricted to a selected group of users, but now it is available to the general public. It contains not only the 30-day

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outlook, but also charts the past month's mean circulation and presents in compact form the coming 30 days' probabilities in temperature and precipitation. Figures are given for most of the large cities in the country; thus this publication is a gold mine of climatological information in a form that is unobtainable elsewhere.

Subscriptions to the **Average Monthly Weather Resume and Outlook** must be accompanied by a postal money order or check payable to the Treasurer of the United States and mailed to the Superintendent of Documents, Government Printing Office, Washington 25, D. C. The subscription price is $4.80 per year or $2.40 for six months; minimum subscription, six months. D. M. L.

COMPENDIUM OF METEOROLOGY

Now available is the **Compendium of Meteorology,** edited by Thomas F. Malone, and published by the American Meteorological Society with the support and sponsorship of the Geophysics Research Division, Air Force Cambridge Research Center. It contains in one volume 1,315 pages and an index, price $12.00.

SCIENCE AND METEOROLOGY ON ALASKA'S HIGHEST MOUNTAIN

(Continued from page 2)

control for eventual detailed mapping of the whole vast McKinley region (including nearby 17,000-foot Mt. Foraker); conducted the first geological collecting right to the summit; and set up for three weeks a cosmic-ray station at 18,200 feet in Denali Pass, for the University of Chicago under contract with the Office of Naval Research.

In 1949, Mr. Washburn took two flights for ONR, with Air Force support, and made numerous helicopter landings to reconnoiter possible climbing routes to the Denali Pass research site. The pass lies between the two peaks, and it was hoped to find an easier and safer route than that usually taken up treacherous Muldrow Glacier.

In 1951, capitalizing on the information gained in the 1949 flights, the Boston Museum scientist, for the museum and the universities of Denver and Alaska, led a successful attempt on Mt. McKinley via the western buttress, never before scaled. This expedition found the safest, shortest, and most practical route to Denali Pass, which may be used whenever further research there is contemplated.

Mr. Washburn has compiled a descriptive bibliography, **Mt. McKinley and the Alaska Range in Literature.** In addition to 264 entries, it contains the original Act of Congress establishing Mt. McKinley National Park in 1917, and an account of the first exploring party to the region north of Cook Inlet, reprinted from the New York **Sun,** January 24, 1897. This paper-bound bibliography (88 pages, 1951) may be obtained directly from the Boston Museum of Science, Boston 14, Mass., for $2.50.

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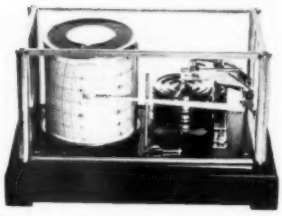


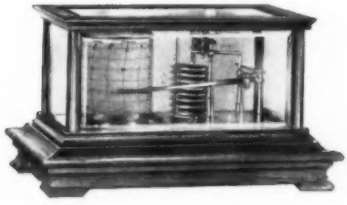
Display Barograph

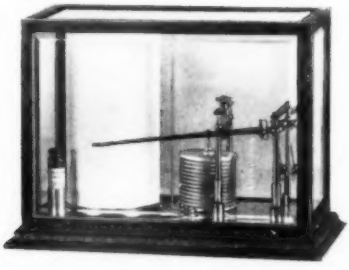
No. 354 Small barograph has powerful, four cell pressure element. Attractive glass case set in chrome with black base. Weekly recording period. Range: 28.00 inches to 31.00 inches. **$100.00**

Deluxe Barograph

No. 352 Attractive recording barometer is ideal for display in office or home. Precision movement. Polished mahogany case has sides of beveled glass. Large rectangular charts. Recording period seven days. Range: 28.00 inches to 31.00 inches. With a drawer for storing charts. **$144.00**

No. 352a Same as above without chart drawer. **$124.00**





Microbarograph

No. 356 Professional recording barometer with expanded scale. Two-and-a-half inches of chart for one inch barometer change. Open scale graduated to 0.02 inch. Temperature compensated sylphon element. Attractive beveled plate glass top and sides. Seven day recording period. Range: 28.5 inches to 31.00 inches. Size: 12″ x 9″ x 6½″. Weight: 17½ lbs. **$225.00**

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